

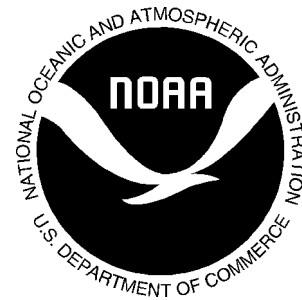
**National Oceanic and Atmospheric Administration**

# **Heat Wave Workshop**

Co-Sponsored by  
U.S. Centers for Disease Control and Prevention  
and  
Environmental Protection Agency

September 18-19, 1996  
Silver Spring, Maryland

## ***Report***



**National Oceanic and Atmospheric Administration**

# **Heat Wave Workshop**

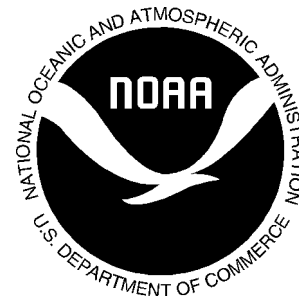
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Prepared by  
**Christopher R. Adams**  
Office of Meteorology  
National Weather Service



## **ACKNOWLEDGMENTS**

Many people contributed to the success of this Heat Wave Workshop. Those making presentations or chairing sessions are mentioned in this report, and their contributions are acknowledged and appreciated. Others contributed to the planning and conducting of this workshop. Their hard work and professionalism made this workshop possible. Kathryn Sullivan, former NOAA Chief Scientist, pushed the original idea of this gathering. Derek Winstanley, formerly of the Office of the NOAA Chief Scientist, provided support and assistance. Gib Parrish, Mike McGeehin, and Edwin Kilbourne of the U.S. Centers for Disease Control and Prevention provided their encouragement, invaluable help in co-sponsoring the Workshop, and coordination within the public health community. Joel Scheraga, Anne Grambish, and Alexander Winslow from the Environmental Protection Agency lent their efforts in supporting and co-sponsoring the workshop. Laurence Kalkstein of the University of Delaware offered his sage insight in organizing the sessions. Rich Przywarty and Don Wernly of the National Weather Service provided assistance in obtaining scarce resources. Finally, our thanks go to John Skoda and Linda Kremkau, National Weather Service, for their support and assistance with the Workshop and the final report.

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## **EXECUTIVE SUMMARY**

The July 1995 Heat Wave, which killed 522 people in Chicago, triggered a National Oceanic and Atmospheric Administration (NOAA) Disaster Survey to document the weather warning and forecast process and evaluate the delivery of services by the National Weather Service (NWS). As part of the research on the July 1995 Heat Wave, research from the U.S. Centers for Disease Control and Prevention (CDC) revealed the extent of the deadly nature of heat waves. According to CDC, on average 384 people were killed by excessive heat each year during the period from 1979-1992. The highest annual number of heat-related deaths for that period was 1,700 in the summer of 1980.

As recommended in the NOAA Disaster Survey, NOAA conducted a Heat Wave Workshop. This workshop was co-sponsored by the CDC and the Environmental Protection Agency (EPA). All three agencies contributed to the planning and conducting of the Workshop. This Workshop was conducted by the NWS under the auspices of the NOAA Chief Scientist. The four goals for this Workshop were:

- Bring together interested agencies, groups, companies, and individuals.
- Develop a common understanding of heat waves as natural hazards.
- Identify solutions to reduce the disastrous impacts of these events.
- Create an action plan to jointly implement disaster reduction solutions.

To accomplish this, the Workshop was organized to first provide a common understanding of the problem and issues. Three panels of experts presented information on: (1) the Chicago heat wave, (2) Federal agencies roles, and (3) state and local heat wave response programs.

Workshop attendees broke into three working groups to identify issues and concerns and develop action plans. These three groups addressed the following:

- Current warning and forecast practices.
- Research requirements for improved warnings, forecasts, and health impacts.
- Identify successful state and community intervention strategies.

Their findings and recommendations included:

#### *Research Requirements*

- Establish an interagency task force to coordinate and focus research activity.
- Evaluate existing heat-related watch/warning systems and models.
- Develop an optimal heat wave watch/warning system.
- Assess the availability of excessive heat mortality and morbidity data.
- Evaluate community education and prevention efforts.
- Evaluate mitigation efforts.

#### *Current Heat Wave Warning and Forecast Practices*

- There is a need for a uniform definition of “Heat Wave.”
- Revise the heat program procedures to allow more flexibility in the operations of the local NWS offices.
- Evaluate current products and user understanding of terminology.
- Define cancellation criteria for NWS heat-related products.
- Develop and conduct NWS preparedness programs for excessive heat, targeting training for the media and state/local officials, and public education.

#### *Successful State and Community Intervention Programs*

- Develop a model excessive heat response action plan for multiple agencies. This should address:
  - Preparedness -- public education, training, exercises, resource management, warning systems, housing.
  - Response -- command systems, intervention programs, emergency public information, staged warnings, mass care, tracking of health impacts.
  - Recovery -- de-activation, continued monitoring of health effects, mental health intervention, community development.
  - Evaluation -- evaluating and modifying response plan, epidemiological studies, cost/benefit analysis.

The Nation is at a point to incorporate advances in atmospheric science understanding, emergency management, and public health to enhance our ability to predict, warn, and respond to deadly heat waves. Federal, state, and local officials; local organizations; the news media; and the private sector have an opportunity to jointly work to reduce the deadly tolls from these natural disasters. This Workshop is the first step in this collaborative effort.

# **RECOMMENDATIONS**

## **Current NWS Heat Wave Forecast and Warning Practices Working Group**

**Recommendation:** Develop/refine a definition of heat wave that is satisfactory for NWS operational needs.

**Recommendation:** NWS Headquarters, Office of Meteorology, should lead the effort to revise heat program procedures contained in Weather Service Operations Manual (WSOM) Chapter C-44, "Non-Precipitation Weather Hazards," to allow more flexibility in the operations of the local offices. Every effort should be made to accomplish these changes before the next summer season.

**Recommendation:** NWS local offices should conduct outreach campaigns to local and state agencies, the media, and other organizations to ensure full understanding of NWS products and procedures.

**Recommendation:** In the revision of WSOM Chapter C-44, cancellation criteria for heat-related products must be defined in conjunction with the development of flexible issuance criteria.

### **Recommendations:**

- (1) Each NWS field office must develop local criteria in conjunction with local and state agencies.
- (2) At the start of warm season and again before significant events, the NWS, local, and state agencies should publicize those criteria to the public and media.
- (3) NWS Headquarters should take the lead in preparing brochures, etc., and provide updated instructions to the field offices (NWS Operations Manual Letter [OML] or Chapter C-44 update). This will include working with the Federal Emergency Management Agency (FEMA), the American Red Cross (ARC), the Administration on the Aging (AoA), the CDC, public utilities, and others to share costs and develop materials useful to a wide spectrum of the public.

## **Research Requirements to Better Forecast and Mitigate the Effects of Heat Waves Working Group**

**Overall Recommendation:** *The working group recommends that an interagency research task force be formed to coordinate and promote research relating to excessive heat and its impact on the public. This task force should include Federal, state, and local agencies.*

**Research Recommendation:** Conduct an evaluation of Dr. Kalkstein's air mass based mortality prediction system, apparent temperature methodology, and a hybrid system that includes temperature, humidity, and one or more additional factors. The comparative evaluation will consist of ten cities over different climate zones. One outcome of this evaluation study will be a recommendation to the National Weather Service for the most appropriate interim mortality based watch/warning system.

**Research Recommendation:** Development of an Optimal Heat Wave Watch and Warning System.

**Research Recommendation:** Conduct an assessment of availability of morbidity and mortality data as applicable to the study of excessive heat.

**Research Recommendation:** Conduct an evaluation of community and state education and prevention efforts.

**Research Recommendation:** Conduct a comparative evaluation of community and state mitigation efforts and programs.

## **Identifying and Transferring Successful Community Intervention Strategies Working Group**

**Recommendation:** Conference proceedings should be widely distributed to a variety of interested agencies and organizations. This should include mailings, distribution to Federal agencies, and posting on the Internet.

**Recommendation:** A heat wave multi-agency working group should be established and convened by November 15, 1996. It should be made up of Federal agencies, such as FEMA, CDC, NWS, AoA, and EPA, as well as appropriate state and local agency representatives from the public health, aging, and emergency management and response communities. This working group should develop a local community heat wave preparedness planning tool.

**Recommendation:** The final recommendations from the heat wave multi-agency working group should be made available to state and local governments in time to be implemented in the 1997 summer heat season.



## **Follow-up Actions**

Each working group has continued on its own to accomplish the critical tasks identified during the Workshop sessions. The passionate dedication of these individuals to reduce the deadly impacts of heat waves is a reflection of the spirit exhibited during the Workshop.

National Oceanic and Atmospheric Administration

# Heat Wave Workshop

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and  
Environmental Protection Agency

September 18-19, 1996  
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## **INTRODUCTION**

The July 1995 Heat Wave, which killed 522 people, triggered a NOAA Disaster Survey to document the weather warning and forecast process and evaluate the delivery of services by the NWS. The team was comprised of scientists from a variety of disciplines, including meteorology, oceanography, sociology, and epidemiology. Their findings encouraged the NOAA Chief Scientist to hold a workshop on heat waves to identify lessons learned and solutions to reduce the impacts of heat waves on the Nation. Specifically, the team recommended that:

The NOAA Chief Scientist should convene a workshop comprised of interagency physical scientists, private sector providers, social scientists, and epidemiologists to provide operational research recommendations in light of the scientific advances made over the last decade. The relationship between heat-related mortality and the heat index, as well as other proposed predictors of heat stress, should be simultaneously evaluated to determine which method most accurately predicts the health consequences of a heat wave.

and that:

NOAA should actively encourage other Federal agencies, such as the Department of Health and Human Services, the Environmental Protection

Agency, and the Federal Emergency Management Agency, to join in research on excessive heat, mortality, and morbidity.<sup>1</sup>

As part of the research on the July 1995 Heat Wave, research from the CDC revealed the extent of the deadly nature of heat waves. According to CDC, on average 384 people were killed by excessive heat each year during the period from 1979-1992. The highest annual number of heat-related deaths for that period was 1,700 in the summer of 1980.

The NOAA Heat Wave Workshop was co-sponsored by the CDC and the EPA. All three agencies contributed to the planning and conducting of the Workshop. There were four goals for this Workshop:

- Bring together interested agencies, groups, companies, and individuals.
- Develop a common understanding of heat waves as natural hazards.
- Identify solutions to reduce the disastrous impacts of these events.
- Create an action plan to jointly implement disaster reduction solutions.

To achieve these goals, the Workshop was organized to first provide a common understanding of the problem and issues. Three panels of experts presented information on: (1) the Chicago heat wave, (2) Federal agencies roles, and (3) state and local heat wave response programs. Following the presentations the first morning, Workshop attendees broke into one of three working groups to identify issues and concerns and develop action plans. These three groups addressed:

- Current warning and forecast practices.
- Research requirements for improved warnings, forecasts, and health impacts.
- Identify successful state and community intervention strategies.

This report summarizes the presentations of the three panels. It presents a detailed account of the findings of each of the working groups. The specific action plans of each group of Workshop participants are presented.

Follow-on work conducted by each working group is summarized in Appendix D. Each working group has continued on its own to accomplish the critical tasks identified during the Workshop sessions. The passionate dedication of these individuals to reduce the deadly impacts of heat waves is a reflection of the spirit exhibited during the Workshop.

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<sup>1</sup> July 1995 Heat Wave Natural Disaster Survey Report, U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Weather Service, Silver Spring, Maryland. December 1995. For copies contact: Customer Service Core (W/OM11), NOAA/National Weather Service, 1325 East-West Highway, Room 14362, Silver Spring, MD, 20910, or on the Internet, go to the NWS Office of Meteorology's Home Page at <http://www.nws.noaa.gov/om/omhome.htm>.

## **SPEAKERS**

### **Welcome**

*Dr. Alfred M. Beeton, Acting NOAA Chief Scientist*

Dr. Beeton welcomed the participants to this important Workshop, combining Federal, state, and local officials; service organizations; and scientists from various fields to address the problem of heat wave disasters. He thanked the co-sponsors, CDC and EPA, for their assistance in planning, organizing, and supporting the Workshop.

He stressed that heat is a silent killer. CDC has documented that from 1979-1992, on average 384 people died each year due to excessive heat. This is greater than the 30-year average annual number of deaths due to hurricanes, floods, tornadoes, and lightning combined.

This Workshop is a follow up to the NOAA Disaster Survey Report: July 1995 Heat Wave Report. This was a tragic event with 522 heat-related deaths in Chicago alone. As a result of the Survey, we identified agencies and groups to be brought together to share knowledge and insights and to collaborate to reduce health impacts of heat waves.

He set forth his goals for the Workshop to:

- Bring together interested agencies, groups, companies, and individuals.
- Develop a common understanding of heat waves as a natural hazard.
- Identify solutions to reduce the disastrous impacts of these events.
- Create an action plan to jointly implement disaster reduction solutions.

Dr. Beeton briefly discussed the overview of the Workshop, including the informal panel presentations on:

- The Chicago heat wave.
- Federal agency roles.
- State and local programs to deal with heat waves.

The participants then broke into three working groups to identify issues and recommendations. These included:

- Current warning and forecast practices.
- Research requirements for improved warnings, forecasts, and health impacts.
- Identify successful state and community intervention strategies.

Dr. Beeton concluded by thanking all the participants for their contributions to making this a successful endeavor.

## 1995 Chicago Heat Wave

*Mr. Eugene P. Auciello, Meteorologist in Charge, NWS Forecast Office Albany, New York, Technical Leader, NOAA July 1995 Heat Wave Survey Team*

Mr. Auciello discussed the reasons behind the NOAA Disaster Survey Team being created by Dr. Elbert W. Friday, Jr., NOAA Assistant Administrator for Weather Services (Director of the National Weather Service). He presented the make-up of the survey team, combining physical and social scientists from NOAA and CDC with operational staff from NWS field offices to document the forecast and response processes in this disaster. The survey team focused on Chicago but also documented the impacts and response in the Milwaukee, Wisconsin, area. The team went on to study two “success stories” of community response in St. Louis, Missouri, and Philadelphia, Pennsylvania. He stressed that heat may be one of the most underrated killers of all weather hazards. He presented the highlights of the NOAA July 1995 Heat Wave Survey Report. This report calls for this Workshop to jointly address issues that arose as part of this study. Mr. Auciello briefly talked about the key findings and recommendations of the survey team (see Appendix B). These point out the need for recognition across agencies at the Federal, state, and local levels of the deadly nature of heat waves. He concluded with the need for cooperative interagency planning and preparedness for these disasters.

*Dr. Robert E. Livezey, Climate Prediction Center, NOAA July 1995 Heat Wave Survey Team*

Dr. Livezey presented the meteorological and climatological description of the July 1995 Heat Wave and the factors that contributed to its severity. The combination of high heat and relative humidity made this an unprecedented event in a number of respects. The main cause of the July 1995 Heat Wave was a slow moving, hot, and humid air mass produced by a very strong upper-level ridge of high pressure moving over unusually moist ground. Several unique conditions combined to create this deadly heat wave. The July 1995 heat wave was made worse by local effects in Chicago, particularly the urban heat island effect which makes it hotter in the urban core than in surrounding areas. Dr. Livezey referred to a more detailed discussion in the Heat Wave Report and also mentioned recent professional articles discussing the July Heat Wave.<sup>2</sup>

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<sup>2</sup> See “Chapter 1 - Meteorological/Climatological Analysis” in the July 1995 Heat Wave Natural Disaster Survey Report. Also see Kunkel, Kenneth E., et al., 1996: “The July 1995 Heat Wave in the Midwest: A Climatic Perspective and Critical Weather Factors,” *Bulletin of the American Meteorological Society*, v. 77, n. 7, 1507-1518.

*Dr. John L. Wilhelm, Deputy Commissioner, Chicago Department of Public Health*

Dr. Wilhelm was in charge of the Chicago heat response plan when the July 1995 Heat Wave occurred. He indicated that the response, not the science, failed in Chicago. The event was so unique that its impacts were not anticipated. The original Chicago plan had worked in previous years. It involved coordinating with the media and setting up cooling centers. The July 1995 Heat Wave overwhelmed the response capacity.

The July 12-16, 1995, Heat Wave produced 522 heat-related deaths based on the final analysis of death certificates by the Chicago Department of Public Health. This is the final official count of deaths in Chicago. The earlier figure of 465 deaths reported by CDC and NOAA was based on the initial death count from local health officials. The deadly impacts of the July 1995 Heat Wave has been studied by the city, county, and state health departments. In addition, the CDC was asked to conduct a detailed study of those at risk. Their findings indicate that those most at risk were the elderly, with medical illnesses, who were socially isolated and had no access to air conditioning.<sup>3</sup>

Immediately following the heat wave, Chicago Mayor Richard M. Daley began a formal review of the city's response. The Mayor's Commission on Extreme Weather Conditions looked in-depth at the heat wave response and its preparedness for all hazardous weather events. The Commission was divided into seven working committees to look at factors, including weather, morbidity and mortality, the elderly, communications, and the roles of governments, and the private sector. Their work produced a final report and a new "Extreme Weather Operations Plan" for the city.<sup>4</sup>

Dr. Wilhelm reminded the participants that government is not the answer. Government can coordinate and communicate risk and protective actions. People have to reach out and help each other in times like this.

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<sup>3</sup> Semenza, Jan C., et al., 1996: "Heat-Related Deaths during the July 1995 Heat Wave in Chicago," *New England Journal of Medicine*, v. 335, n. 2, 84-90. Also see Chagnon, Stanley A., et al., 1996: "Impacts and Responses to the 1995 Heat Wave: A Call to Action," *Bulletin of the American Meteorological Society*, v. 77, n. 7, 1497-1506.

<sup>4</sup> Final Report: Mayor's Commission on Extreme Weather Conditions. City of Chicago, November, 1995.

## **Federal Agencies' Roles in Heat Waves**

*Mr. David Gardiner, Assistant Administrator, Office of Policy, Planning, and Evaluation, Environmental Protection Agency*

Mr. Gardiner talked about the importance of this Workshop to bring together such a diverse set of organizations with a mutual interest in solving the problem of heat waves becoming disasters. He talked about the role of the EPA in studying and documenting the long-term effects of climate change and global warming. The EPA's interest is in the combined effects on society of climate change and pollution. As part of the Intergovernmental Panel on Climate Change, the EPA anticipates that the frequency of heat waves will increase. Human activities are impacting the climate and causing changes. These changes will have an increased negative impact on health.

The EPA has supported research aimed at developing potential early health warning systems to help identify those atmospheric patterns that lead to increased health problems. Specifically, they have funded the work of Professor Laurence Kalkstein at the University of Delaware to identify climate conditions that negatively impact human health.

The EPA is dedicated to reducing pollution which can increase climate extremes and lead to global climate change. Mr. Gardiner encouraged participants to help support research on heat wave warning systems.

*Dr. Susan F. Zevin, Deputy Assistant Administrator for Operations, National Weather Service, National Oceanic and Atmospheric Administration*

Dr. Zevin welcomed the participants and thanked the co-sponsors of the Workshop. She provided a brief overview of the NWS, which is part of NOAA and the Department of Commerce. The primary mission of the NWS is to provide weather and flood warnings, watches, and forecasts to protect the public. The NWS is the only Federal agency with the mission to issue weather and flood warnings. She talked about the NWS modernization which includes the National Centers for Environmental Prediction, 6 Regional Headquarters, 119 local Weather Forecast Offices, and 13 River Forecast Centers.

Dr. Zevin outlined the warning and forecast operations of the NWS. The hazardous weather watch/warning programs follow a three-tiered concept of outlooks, watches, and warnings or advisories. The watch/warning process is based on the forecast Heat Index (or

Apparent Temperature) coming from the research of Dr. Robert Steadman at Colorado State University in the 1970's.<sup>5</sup> The excessive heat must occur for 2 consecutive days to trigger an Excessive Heat Warning. Each region in the country has some flexibility to modify temperature thresholds for watches and advisories to reflect local conditions and requirements. Local NWS offices coordinate excessive heat warning services with state and local officials, and with other agencies through their Warning Coordination Meteorologists.

She discussed the deadly nature of heat waves. They are invisible, silent, and insidious like a drought. Heat waves require warning partnerships among all levels of government, the media, and other organizations. The threat is more than meteorological. Key social variables—urbanization, extended families, and housing construction—contribute to the disaster. There are also individual risk factors that make people more susceptible, such as age, health, and medications. Finally, there are climatological variables, such as region of the country and time of season, that contribute to their deadliness.

Dr. Zevin concluded with three goals she had for the Workshop.

- Work with warning partners to improve excessive heat warning and forecast services.
- Incorporate successful state and local intervention strategies into NWS operations and training.
- Identify promising new research for improving excessive heat warnings and forecasts.

*Dr. Thomas Sinks, Associate Director for Science, National Center for Environmental Health, U.S. Centers for Disease Control and Prevention*

Dr. Sinks presented an overview of the public health approach to dealing with heat waves. The approach to such public health is:

Surveillance (Problem) ⇒ Risk Factor Identification (Cause) ⇒ Intervention Evaluation (What Works) ⇒ Implementation (How Do You Do It)

Problem-----Response

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<sup>5</sup> Steadman, Robert G., 1979a: "The Assessment of Sultriness. Part I: A Temperature-Humidity Index Based on Human Physiology and Clothing Science." *Journal of Applied Meteorology*, v. 18, 861-873; and Steadman, Robert G., 1979b: "The Assessment of Sultriness. Part II: Effects of Wind, Extra Radiation, and Barometric Pressure on Apparent Temperature." *Journal of Applied Meteorology*, v. 18, 874-884.



He discussed what is known by epidemiologists about risk factors for mortality in heat waves. These include:

- the elderly,
- pre-existing medical conditions,
- no access to air conditioning,
- social isolation, and
- lack of awareness of heat danger.

There are known effective interventions, including:

- effective public awareness campaigns,
- early warning,
- focused outreach programs,
- access to air conditioning, and
- education of home health care helpers.

Dr. Sinks mentioned the prevention guide produced by CDC entitled “Extreme Heat: A Prevention Guide to Promote Your Personal Health and Safety.” He made several recommendations to the Workshop, including developing community-wide plans, providing early warnings by the NWS, producing comprehensive coordination of services, and conducting outreach to the community.

*Mr. Gregory Wilder, Disaster Officer, Region VII, Administration on the Aging*

Mr. Wilder talked about the population at greatest risk from heat waves—the elderly. The age group of 85+ is the fastest growing age group in the Nation. Most of them are staying at home, not at facilities. Forty-seven percent of these elderly show symptoms of Alzheimer disease.

The AoA is part of the Department of Health and Human Services. They are authorized to assist in presidentially declared disasters. A major contribution they have made is the production of a Disaster Preparedness Manual for The Aging Network in 1995. Mr. Wilder played a significant role in this project which points out the unique problems and responses of the elderly. It advises agencies on how to be better prepared to assist the elderly in all disasters, including heat waves. There is a section devoted to disaster insights on heat waves. In many ways, the AoA has taken a lead in preparedness for heat waves.

To provide services to the elderly, the AoA has worked with an agency network, consisting of 10 federal regions, each with a disaster officer. There are 57 state agencies, each also has a disaster officer. These state agencies coordinate the 670 area agencies. An additional 27,000 service providers provide direct support for the elderly of this Nation.

## State and Local Heat Wave Programs

*Dr. Lawrence Robinson, Deputy Health Commissioner, Philadelphia Department of Health*

Dr. Robinson discussed the work of the Philadelphia Heat Wave Preparedness Task Force that developed and implemented the Philadelphia Heat Response Emergency Plan. This program was identified by the NOAA survey team as one of the best in the Nation. In 1993, there was a concerted effort in Pennsylvania and Philadelphia to develop an effective heat response program. This was based on earlier documentation of the excess in heat-related deaths by the Philadelphia Medical Examiner, Dr. Haresh Mirchandani. Dr. Mirchandani creatively documented the nature of the problem overlooked by most cities because of the way heat-related deaths were counted. The system developed by Philadelphia provides advanced preparedness and response capabilities. It focuses on providing active assistance to the elderly during excessive heat.

The city's preparedness emphasizes looking after the elderly who are at greatest risk. Early in the season, community workers train students who watch after the elderly in an area using a "buddy system." They try to make contact with as many elderly on a daily basis during excessive heat. The entire city government actively participates in the heat response program. They have an outreach program that includes giving away cooling fans, distributing brochures door to door, and furnishing flyers in utility bill mailings. Even the shopping malls and movie theaters open their doors for the elderly and encourage them to come in out of the heat.

In 1995, Philadelphia started a creative new program to test the effectiveness of a new health impacts prediction model developed by Dr. Laurence Kalkstein at the University of Delaware under EPA funding.<sup>6</sup> This focused on using air mass types to help predict excess mortality due to heat. This model was combined with the Philadelphia NWS Forecast Office (NWSFO) Excessive Heat Outlooks, Warnings, and Watches to provide a unified city-wide preparedness and health response system. The goal is to use advances in scientific understanding of the atmospheric and other conditions that cause heat-related health deaths to develop trigger thresholds for a health watch/warning notification system. This is a model program of cooperation among university, Federal, and local governments.

The Philadelphia health watch/warning system consists of three levels. The Health Commissioner issues either a Health Watch, Health Alert, or a Health Warning. A Health Watch is issued 48 hours in advance of the forecast arrival of the high risk air mass. A Health Alert is issued 24 hours in advance, and the Health Warning is issued for that day(s) in conjunction with the NWS issuance of an Excessive Heat Warning. This system allows for the staged mobilization of community-wide resources in a coordinated manner to assist those most at risk from the health impacts of excessive heat.

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<sup>6</sup> Kalkstein, Laurence S., et al., 1996: "The Philadelphia Hot Weather Health Watch/Warning System: Development and Application, Summer 1995." Bulletin of the American Meteorological Society, v. 77, n. 7, 1519-1528.

*Dr. H. Denny Donnell, Jr., State Epidemiologist, Missouri Department of Health*

Dr. Donnell discussed the heat wave history of Missouri that lead up to their plan and operations. In the summer of 1980, 295 heat-related deaths occurred in Missouri. This triggered the state's review of its capabilities. The Missouri Health Department worked to develop the state response plan. There were 71 heat-related deaths in 1983. Missouri experienced 57 heat-related deaths in the heat wave of 1995.

He discussed the Missouri heat crisis procedures. Their program is based on the NWS forecasts from the local NWSFO's. There are three levels that were adopted by the state health department in 1988. The first is a Heat Warning based on a forecast Heat Index of 105°F during the day. When this occurs, the state health department releases a news release to the media advising the public about heat wave safety precautions. The next higher level is a Heat Alert. This is issued when the Heat Index reaches 105°F for 2 consecutive days and is predicted for 48 hours more over a large portion of the state. This triggers local response actions to provide relief. Local health departments are encouraged to open cooling centers. The highest stage is a statewide Heat Emergency.

The Governor declares a Heat Emergency at the recommendation of the Missouri Department of Health. This is triggered by extensive areas of the state experiencing high levels of heat stress (Heat Index of 105°F or above for 3 days), increased levels of heat illness or deaths, and the NWS is predicting more hot and humid conditions. At this point, the Missouri State Emergency Management Agency becomes the state level coordination agency.

*Mr. Samuel H. Jordon, Director, Washington, DC, Office of Emergency Preparedness*

Mr. Jordon talked about the city of Washington, DC's, new health watch/warning program. It is modeled after the Philadelphia program. After the Chicago heat wave, city officials reviewed their preparedness for such disasters and revised their plan. They utilize the same community-based approach, calling on various city agencies to assist in the program. They have also set up outdoor cooling stations using a misting system at various locations in the city. They are working closely with the University of Delaware and the local NWSFO in Sterling, Virginia. They will be the second city to test the air mass model for activating their community response to extreme heat events.

Their program is newer than either Philadelphia or St. Louis. They reviewed the reports from both Chicago and Philadelphia and incorporated lessons learned into their program. Next summer will be the first full summer to test out their new health watch/warning system.

*Dr. Laurence S. Kalkstein, Professor, Department of Geography, University of Delaware*

Dr. Kalkstein has developed a synoptic climatological model, with funding from the EPA, to identify high risk/offensive air masses associated with heat-related deaths. The model he has developed is location specific, i.e., it must be modified for each location. The approach identifies commonly occurring summer air masses and identifies those related to excess mortality during hot temperatures. It also takes into account the time of the summer season and the days within the air mass's occurrence that pose the greatest threat.

He pointed out that the population of various cities respond to weather in a relative fashion. Seasonal and regional variations must be accounted for in predicting health impacts of weather. We need to develop better ways to define "Heat Waves" in terms of the specific conditions that pose a threat to health. What is deadly in one city may be a more normal occurrence in another. Third, whatever approach is taken, it must be a coordinated effort among agencies and jurisdictions to effectively communicate risk to the public.

His work is the basis of the Philadelphia health watch/warning system. His team provides predictions to the city of Philadelphia Health Department of potentially hazardous hot air masses two days before they arrive. He coordinates his health forecasts with the Philadelphia NWSFO. This provides a longer lead time for the city and a coordinated message going to the media and public. He has expanded his research to include operational models for Washington, DC, and Phoenix, Arizona. Both communities have revised their local emergency and health response plans to incorporate more preparedness and response before the heat impacts.

Dr. Kalkstein concluded with a challenge to the Workshop participants to help develop and evaluate his health impacts predictive model for other cities. He encouraged an evaluation of the model's effectiveness compared to other ways to predict harmful heat waves. If it proves to be a better predictor, then advances in science can be used to help communities better respond to deadly heat waves.

*Ms. Nancy Buechler, Operation Weather Survival, St. Louis Department of Health and Hospitals*

In 1980, St. Louis experienced an extreme heat wave, killing 113 people. This started the Operation Weather Survival Program in St. Louis. It is a loose affiliation of organizations and agencies that band together to deal with the problem posed by both extreme heat and cold. They have an extensive plan of operation for heat waves. There is year-round coordination among the members of Operation Weather Survival to help ensure their readiness. Their heat program has sought out donations of hundreds of air conditioners which they distribute on a need basis. They also have a community outreach program to the neighborhoods through various agencies and organizations. The city sets up a computer operated calling system to check on known elderly residents who are susceptible to heat-related illness. They also establish cooling centers for people to get out of the heat.

The Operation Weather Survival's Heat Response Plan is activated by Heat Warnings issued jointly by the St. Louis Department of Health and Hospitals and the St. Louis County Health Department. These warnings are not based on any watches or warnings issued by the local NWSFO in St. Louis. Rather, they issue their own independent warnings based on readings of a wet bulb globe thermometer monitored at the St. Louis Department of Health and Hospitals. When the readings for the previous afternoon and that day average 85°F or more, a Heat Warning is issued by the city and county. This activates increased surveillance of the hospitals for heat illnesses. The next level of activation is a Heat Alert. This activates the various social services agencies and opens the cooling centers. The highest level is a Heat Emergency which is called by the chief executive of the city, county, or state.

## **WORKING GROUPS**

The participants next broke up into three discussion working groups. Each group addressed different issue areas related to heat wave response, planning, and research. The goal of each working group was for the participants to identify key issues and a plan of action in the discussion area. The group put these issues in a priority ranking. Each group took the most important four or five issues and identified actions needed to address these issues. These action plans included identifying groups and agencies to serve on task teams, time tables, specific actions necessary, and follow up.

### **Current NWS Heat Wave Forecast and Warning Practices Working Group**

*Facilitator — Kevin C. McCarthy, NWS Office of Meteorology Public Weather Program Leader*

#### **Discussion Questions:**

- What is a Heat Wave?
- From users perspective, are current NWS forecast operations for excessive heat adequate to meet their information and decision-making requirements?
- Are there any changes in operations the NWS should consider?
- Is there any confusion over language and products, i.e., watch vs. warning vs. advisory?

### **Research Requirements to Better Forecast and Mitigate the Effects of Heat Waves Working Group**

*Facilitator — John Feldt, Meteorologist in Charge NWS Forecast Office Des Moines, Iowa (Heat Wave NOAA Disaster Survey Team Member)*

#### **Discussion Questions:**

- What is a Heat Wave?
- Are there gaps in our knowledge about the effects of excessive heat on health?
- Are there gaps in our understanding of and ability to predict deadly heat waves?
- Do we understand what makes an effective intervention program for heat waves?

- Is there additional research necessary to improve predictions, warnings, and community response?
- How might this research be coordinated to meet the scientific needs and operational requirements of agencies?

## **Identifying and Transferring Successful Community Intervention Strategies Working Group**

*Facilitator — Mike Franjevic, Warning Coordination Meteorologist NWS Forecast Office Phoenix, Arizona (Heat Wave NOAA Disaster Survey Team Member)*

### Discussion Questions:

- What is a Heat Wave?
- What are the existing effective state and local excessive heat response programs? How would you define effective? How could they be documented for use by other communities?
- Is there a need for training of communities in how to prepare for and respond to heat waves? Who should be involved in that training? How could it be done?

## **GROUP REPORTS**

### **Current NWS Heat Wave Forecast and Warning Practices Working Group**

#### **Issue: *Heat Wave — Definition***

The group spent an extended period of time attempting to define the term. The following definition must be coupled with the specific criteria in use (temperatures, humidity, duration, etc.) which may vary from location to location.

**Heat Wave: “A period of excessive daytime and nighttime heat in association with high humidity relative to geographic location and time of year.”**

The discussions surrounding the definition of heat wave led to the identification of possible parameters that may need to be considered when determining future criteria to be used in NWS operational procedures. The primary requirement of any new procedures is that they must be flexible so that the office may adapt them for local use in conjunction with local government officials.

**Recommendation:** Develop/refine a definition of heat wave that is satisfactory for NWS operational needs.

#### **Issue: *Possible Criteria for Local NWS Offices***

Below is the listing of possible factors that were identified by the working group for local NWS field offices to use in determining the criteria for issuing excessive heat watches, advisories, and warnings for their county warning area. These criteria will be developed in cooperation with local emergency management and health department officials. Only those criteria pertinent to the geographic area need to be considered.

- Climatology and forecast
  - maximum temperature
  - minimum temperature
  - relative humidity
- Cloud cover
- Duration of heat
- Location (urban/suburban/rural)
- Pollution
- Time of year
- Ventilation



It was noted that heat is not as much of a problem in southern locations where air conditioning is more common, but it may become a problem quickly in the event of a widespread electric power outage. In those areas, it is suggested that NWS work with the local emergency management and health community to issue Civil Emergency Messages (CEM) via NOAA Weather Radio (NWR) and NOAA Weather Wire Service (NWWS) if it is jointly determined to be necessary should an outage occur.

**Recommendation:** NWS Headquarters, Office of Meteorology, should lead the effort to revise heat program procedures contained in WSOM Chapter C-44, “Non-Precipitation Weather Hazards,” to allow more flexibility in the operations of the local offices. Every effort should be made to accomplish these changes before the next summer season. (See Appendix D.)

### **Issue: *Heat Program Products***

The discussion of terminology and products that are used in the NWS heat response program revealed much inconsistency within the NWS in the use of the products as well as disparities with the terminology used by other agencies. It was suggested that NWS survey its users to determine the level of understanding of the terminology used. In recognition that a survey could not be conducted easily, it was decided to recommend continued use of the standard suite of NWS products in issuing information concerning the threat from heat but with the understanding that there will be some difference in how the products are used based on local needs.

#### Heat Program Products:

- Outlook — issued for potential events beyond about 48 hours.
- Watch — issued when an event is possible within about 36 to 48 hours.
- Advisory — issued when there is good certainty that a heat event will occur of such a magnitude that it may have some health impacts within the next 12 to 24 hours.
- Warning — issued when there is good certainty that a heat event will occur of such a magnitude that it may have significant health impacts and may be potentially deadly.

Part of the NWS mission is also to provide for the protection of property and to enhance commerce. These items are not encompassed directly in the criteria, but safety of property and commerce is enhanced through the application of the information provided. For example, the operations of the responding agencies, utilities, and emergency service providers rely greatly on the products from the NWS that are related to heat.

**Recommendation:** NWS local offices should conduct outreach campaigns to local and state agencies, the media, and other organizations to ensure full understanding of NWS products and procedures.

### **Issue: *Cancellation of Heat Warnings and Advisories***

In addition to issuance criteria, the possibility of cancellation criteria was also discussed. Again, flexibility was a key to the development of any cancellation criteria. For example, take a case where the temperature criteria for the issuance of an advisory was not met for a forecast period (day or night) but was forecast to exceed the threshold the following period(s). It would be better to continue the advisory or warning through the “cooler” period where the thresholds were not reached rather than attempting to cancel and then reissue the advisory or warning and thereby cause the curtailment and restart of the response systems.

NWS should attempt to provide information on the duration of an extreme heat event even though it may be uncertain because such information is needed by users for planning their response and marshaling sufficient resources. As with the issuance criteria, cancellation criteria should be developed locally in coordination with the emergency management community.

**Recommendation:** In the revision of WSOM Chapter C-44, cancellation criteria for heat-related products must be defined in conjunction with the development of flexible issuance criteria.

### **Issue: *Preparedness***

As with all other hazards that NWS provides warning and forecast information, there is a need not only for the development of internal planning and procedures but also a need for training and outreach to the general public, media, and local officials. This has already started for emergency managers with the inclusion of excessive heat as one of the weather hazards taught as part of the NWS/FEMA joint training courses for local and state emergency managers. The “Hazardous Weather and Flood Preparedness Course” (Emergency Management Institute Course G-271) is available in each state through the state emergency management agency. There are a number of additional steps to this preparedness effort.

### **Recommendations:**

- (1) Each NWS field office must develop local criteria in conjunction with local and state agencies.
- (2) At the start of warm season and again before significant events, the NWS, local, and state agencies should publicize those criteria to the public and media.
- (3) NWS Headquarters should take the lead in preparing brochures, etc., and provide updated instructions to the field offices (OML or WSOM Chapter C-44 update). This will include working with FEMA, the ARC, the AoA, the CDC, public utilities, and others to share costs and develop materials useful to a wide spectrum of the public.

As a final note, the group felt that severe heat events are relatively rare events. As a result, the experience level at both the NWS field offices and the affected emergency management agencies will be limited the next time an event occurs. Therefore, criteria and instructions must be carefully and completely defined so that response is timely and appropriate by both the NWS field offices and emergency management agencies.

## **Research Requirements to Better Forecast and Mitigate the Effects of Heat Waves Working Group**

**Goal:** Identify the research requirements necessary to better forecast and warn for and mitigate the harmful health effects of excessive heat.

**Overall Recommendation:** *The working group recommends that an interagency research task force be formed to coordinate and promote research relating to excessive heat and its impact on the public. This task force should include Federal, state, and local agencies.*

The mission of this task force includes the coordination and direction of research efforts and identification of potential funding sources.

Securing funding for the five research recommendations listed below is critical to the completion of the initiatives described.

### **Issue: Lack of Comparative Scientific Data**

There is a lack of comparative scientific evidence on the accuracy of existing heat-related watch and warning systems and predictive models.

**Research Recommendation:** Conduct an evaluation of Dr. Kalkstein's air mass based mortality prediction system, apparent temperature methodology, and a hybrid system that includes temperature, humidity, and one or more additional factors. The comparative evaluation will consist of ten cities over different climate zones. One outcome of this evaluation study will be a recommendation to the National Weather Service for the most appropriate interim mortality based watch/warning system.

A subcommittee of Dr. Chris Barnes (Los Alamos National Laboratory), Dr. Laurence Kalkstein (University of Delaware), Dr. Robert Livezey (NOAA), Dr. Gib Parrish (CDC), and others as designated will meet within 30 days to design a work plan for this initiative. The plan will be established by January 1997. Depending on funding, this initiative will be concluded by January 1998. (See Appendix D.)

**Research Recommendation:** Development of an Optimal Heat Wave Watch and Warning System.

This project is expected to be of longer duration (1 to 3 years), initially in parallel with research recommendation #1. It will utilize outcomes from the short-term comparison evaluation as well as development of alternate approaches, including computer based artificial intelligence programs. Among research issues to be addressed are:

- Methodology
- Local meteorological factors
- Demographic factors
- Social/mediating factors
- Biological factors

Reconciling user needs and expectation of the user system with the feasible science should be addressed in this initiative.

**Issue:** *Data on Morbidity (Illness) and Mortality (Death)*

Data on morbidity (illness) and mortality (death) related to excessive heat has not been well identified and combined for the study of health impacts of excessive heat.

**Research Recommendation:** Conduct an assessment of availability of morbidity and mortality data as applicable to the study of excessive heat.

This initiative includes the identification of staff and resources to assess currently available morbidity data sources, identification of existing data bases, assessment of usefulness of data sources, and development of additional data bases. In addition, this initiative includes assistance in proper use and implementation of morbidity and mortality data sets.

The lead agency of this initiative is CDC with assistance of others.

**Issue:** *Systematic Evaluation of Programs*

A systematic evaluation of the effectiveness of various heat-related community education and prevention programs has not been conducted.

**Research Recommendation:** Conduct an evaluation of community and state education and prevention efforts.

Prevention efforts are those activities which take place prior to an extreme heat event and are directed to reducing the mortality and morbidity of that event. This initiative will begin with an assessment of evaluation techniques for issues in community outreach, including public

awareness and education, prevention efforts and risk communication. This evaluation should be a joint Federal, state, and local effort.

**Issue: *Evaluation of Mitigation Efforts***

Mitigation (response in the terminology of emergency management) efforts have not been systematically studied to determine the relative effectiveness of actions and programs in the reduction of morbidity and mortality from excessive heat.

**Research Recommendation:** Conduct a comparative evaluation of community and state mitigation efforts and programs.

Mitigation efforts are those activities which are carried out at the time of an extreme heat event to reduce the mortality and morbidity of that event. In this long-term initiative, a study of mitigation efforts and their effectiveness will be conducted. In order to address this initiative, procedures will have to be developed for measurement of danger and measurement of effectiveness. This will be followed by the design of an evaluation system.

## **Identifying and Transferring Successful Community Intervention Strategies Working Group**

**Goal:** To develop a heat response action plan for multiple agencies to use as a generic guide for implementation within individual areas of responsibility. The plan would include identifying and transferring successful, local intervention strategies.

**Heat Wave Definition:** Prolonged period of excessive heat, which may be aggravated by other environmental factors, such as humidity or air pollution, that becomes a hazard to human health.

**Issue: *Lack of Information Sharing***

There is a lack of information sharing among communities nationwide on heat wave impacts, preparedness, and mitigation strategies.

**Recommendation:** Conference proceedings should be widely distributed to a variety of interested agencies and organizations. This should include mailings, distribution to Federal agencies, and posting on the Internet.

### **Issue: *Develop Comprehensive Planning Tools***

There is a need to develop a community response planning tool for heat waves that incorporates successful strategies and is consistent with local emergency management planning guidelines.

**Recommendation:** A heat wave multi-agency working group should be established and convened by November 15, 1996. It should be made up of Federal agencies, such as FEMA, CDC, NWS, AoA, and EPA, as well as appropriate state and local agency representatives from the public health, aging, and emergency management and response communities. This working group should develop a local community heat wave preparedness planning tool. (See Appendix D.)

**Community Heat Wave Planning Tool:** A community based heat wave planning tool should be developed incorporating the following ideas from the working group. This should focus on the heat wave hazard but be incorporated into the overall local community or state disaster response plan.

#### **Plan assumptions and background information**

- The planning tool should provide information learned from previous heat waves, i.e., Chicago, Philadelphia, St. Louis, and Kansas City.
- Use standard emergency management methodology, i.e., preparedness, response, recovery, and mitigation.
- Provide information on where to obtain other state and local plans, i.e., Pennsylvania, Missouri, Philadelphia, Washington, DC, St. Louis, Chicago, Memphis, and Kansas City.
- Evaluation is an on-going process and must be considered throughout all phases of the plan.
- Focus planning and response efforts for populations at greatest risk.
- Use standardized warning message terminology across the Nation.

#### **Planning methodologies**

##### **I. Preparedness issues to be included:**

- Public education
  - Has to be focused to at-risk populace, possible national campaign.

- Training
  - Training on development and implementation of a state and/or local heat response plan.
- Exercises
  - Periodically exercise plan.
- Resource management
  - Each entity developing a heat response plan needs to identify specific agencies within areas of responsibility needed to participate, i.e., public health, fire, police, emergency management, agency on aging, social services, hospitals, emergency medical services, ARC, utilities, churches.
  - Each jurisdiction developing a heat response plan should identify volunteer groups within areas of responsibility needed to participate, i.e., block watch organizations, buddy care programs, Meals on Wheels, veterans organizations, etc.
- Warning systems
  - The plan will require implementation prior to actual occurrence of morbidity and mortality based on a system designed to forecast the event in advance.
- Define triggers
  - Individual entities will need to develop a local hazard analysis to determine at-risk populace, triggering criteria including meteorological and health impacts monitoring, environmental and non-environmental considerations.
- Communications/coordination
  - The plan must provide for dissemination of warning information to decision makers.
- Community demographics
- Housing analysis

## II. Response

- Activate command system
  - Direction and control or coordination.
- Implement intervention programs
  - Provide access to air-conditioned facilities.
  - Open neighborhood cooling centers.
  - Bring cooling systems to individuals such as shut-ins.
  - Daily contact with those at-risk utilizing available resources in place.
  - When possible, utilize support systems already in place.

- Emergency public information
  - Provide frequent and consistent information flow to the public, monitor media and rumor control, public feedback/inquiries, and media relations.
- Issue staged warnings
  - Heat response plan must be modular and capable of implementation at escalating stages of severity, i.e., heat watch, heat advisory, heat warning. Over activation of heat response plan may result in “cry-wolf” syndrome or in unwarranted cost overrides.
- Mass care
  - Consideration must be given to mass care of selected at-risk populace and when the need arises to provide sheltering or evacuations.
- Tracking
  - Response agencies must receive ongoing feedback on changes in morbidity/mortality.

### III. Recovery

- De-activation
  - Determine when incident is over so that a timely down scaling of emergency procedures can be accomplished, allowing at-risk populace to safely return.
- Continue monitoring
  - Procedures must be implemented to continue monitoring at-risk populace for heat or other related medical or non-medical conditions.
- Mental health
  - Provide mental/trauma care for at-risk populace.
  - Provide mental/trauma care for occupational health responders for adverse medical reactions as a result of their response.
- Community Development

### IV. Mitigation

- Public health and life safety codes
- Building codes
- Monitoring and Inspection



- Public education and awareness
- Statutes and ordinances

## V. Evaluation

- Evaluate plan and its implementation
- Epidemiologic studies
  - Case study information--CDC follow up.
- Modify plan--corrective action
  - The emergency response plan must be reviewed and/or modified to maintain accuracy and currency.
- Cost/benefit analysis
  - Serious cost versus benefit considerations must be given when developing procedures to activate heat response plan.

### Other Planning Considerations

- Emergency response functions

Current FEMA state and local disaster response planning guidance includes a variety of key emergency management functions necessary for an effective, coordinated, multi-agency response. These should be incorporated into any hazard specific plan as part of the overall community disaster plan, also known as a local emergency operations plan. These functions include:

1. Direction and control (coordination).
2. Communications—internal and external.
3. Warning coordination and communication.
4. Emergency public information (message content, dissemination of information after warnings, monitoring media and rumor control, public feedback/inquiry [e.g., hot lines], media relations).
5. Evacuation/transportation.
6. Mass care (shelters/cooling centers, provision of water, misting stations).
7. Health and medical (public health, EMS, hospitals).
8. Resource management (utilization of government/community resources, procuring or gaining access to additional resources, including donations).
9. Outreach or community relations (e.g., block captain network).

\*It is suggested that at least these functions—and maybe others—apply in almost all types of emergencies; and that response considerations particular to performing the function in the face of a hazard (like heat wave) be dealt with in hazard-specific appendices to the appropriate functional annexes of an all-hazard emergency operations plan.

- Include public utilities (water, power) in planning and coordination functions.

**Recommendation:** The final recommendations from the heat wave multi-agency working group should be made available to state and local governments in time to be implemented in the 1997 summer heat season.

Follow-on work conducted by each working group is summarized in Appendix D. Each working group has continued on its own to accomplish the critical tasks identified during the Workshop sessions. The passionate dedication of these individuals to reduce the deadly impacts of heat waves is a reflection of the spirit exhibited during the Workshop.



## **CONCLUSION**

This Workshop brought together a diverse set of people with an interest in reducing the deadly impacts of heat waves. They represented public health, environmental, physical science, social science, social service, and emergency response concerns. They came from private organizations, quasi-public organizations, universities, and all levels of government.

There were several important themes that came out of the Workshop. First, heat waves are a deadly epidemic in the Nation. They are more deadly than all other natural hazards. Its cause is known and predictable. Effective interventions are understood and can be readily adopted by local communities. Second, too little attention is paid to heat wave preparedness and response. It is a low salience hazard. Third, efforts in the area of heat wave disaster reduction are fragmented and unorganized. Interested officials must actively seek out sources of information. Agencies are often unaware of the others activities in this area. Finally, while there have been some substantial scientific advances in understanding of atmospheric conditions that are more deadly, populations at greatest risk, and mitigating factors, key collaborative applied research needs to be conducted to better understand, predict, warn, and respond to these deadly atmospheric hazards.

The participants in working groups identified the next steps to help reduce heat wave disasters. First, they called for a focused, coordinated research effort to advance our understanding of the environmental factors, development of the most effective prediction model, understanding the impacts on health, and identifying the most effective intervention strategies. Second, current NWS operations need to better account for local requirements in setting the critical thresholds for Excessive Heat Watches and Warnings. Third, there is a need for more training and outreach in local communities. Fourth, the heat wave warning process must be a combined, coordinated effort among all concerned agencies and organizations in a community. Finally, we must develop a way to communicate effective local heat wave preparedness and response strategies to communities across the Nation. This can be done through a national training program that provides guidelines and background materials to allow local communities and states to develop their own effective programs.

Now is the time to combine all the interested organizations to reduce the Nation's vulnerability to these deadly natural disasters.

## Appendix A

# National Oceanic and Atmospheric Administration Heat Wave Workshop

Co-Sponsored by  
U.S. Centers for Disease Control and Prevention  
and  
Environmental Protection Agency

September 18-19, 1996  
Silver Spring Metro Center, Building 2  
Second Floor Conference Center  
Silver Spring, Maryland

## AGENDA

### Wednesday, September 18

8:30 a.m. Welcome — *Dr. Alfred M. Beeton*, Acting NOAA Chief Scientist

8:45 a.m. 1995 Chicago Heat Wave

*Mr. Eugene P. Auciello*, MIC NWSFO Albany  
Technical Leader, NOAA July 1995 Heat Wave Survey Team

*Dr. Robert E. Livezey*, Climate Analysis Center  
NOAA July 1995 Heat Wave Survey Team

*Dr. John L. Wilhelm*, Deputy Commissioner  
Chicago Department of Public Health

9:45 a.m. Federal Agencies' Roles in Heat Waves

*Mr. David Gardiner*, Assistant Administrator  
Office of Policy, Planning, and Evaluation  
Environmental Protection Agency

*Dr. Susan F. Zevin*, Deputy Assistant Administrator for Operations  
National Weather Service  
National Oceanic and Atmospheric Administration

*Dr. Thomas Sinks*, Associate Director for Science  
National Center for Environmental Health  
U.S. Centers for Disease Control and Prevention  
*Mr. Gregory Wilder*, Disaster Officer,

Region VI  
Administration on the Aging

10:45 a.m. State and Local Heat Wave Programs

*Dr. Lawrence Robinson*, Deputy Health Commissioner  
Philadelphia Department of Public Health

*Dr. H. Denny Donnell, Jr.*, State Epidemiologist  
Missouri Department of Health

*Mr. Samuel H. Jordon*, Director  
Washington, DC, Office of Emergency Preparedness

*Dr. Laurence S. Kalkstein*, Professor  
University of Delaware

*Ms. Nancy Buechler*, Operation Weather Survival  
St. Louis Department of Health and Hospitals

NOON Lunch

1:00 p.m. Participants Breakout into Working Groups

***Group One*** Current NWS Heat Wave Forecast and Warning Practices  
Room 11246 Kevin McCarthy — Facilitator

***Group Two*** Research Requirements to Better Forecast and Mitigate the  
Room 14316 Effects of Heat Waves  
John Feldt — Facilitator

***Group Three*** Identifying and Transferring Successful Community Intervention  
Room 18246 Strategies  
Mike Franjevic — Facilitator

**Thursday, September 19**

8:30 a.m. Working Groups Reconvene — Develop Action Plans  
Same Breakout Rooms

10:30 a.m. Working Groups Report to Entire Workshop  
Second Floor Conference Center

Noon Workshop Adjourns

## Appendix B

# July 1995 Heat Wave NOAA Natural Disaster Survey Findings and Recommendations<sup>7</sup>

The following findings and recommendations are grouped by subject matter and are found within their appropriate chapters as indicated.

## Meteorological/Climatological Analysis

**Finding:** The July 1995 heat wave at Chicago and Milwaukee was a highly rare and, in some respects, unprecedented event in terms of both unusually high maximum and minimum temperatures and the accompanying high relative humidities.

**Finding:** The principal cause of the July 1995 heat wave was a slow-moving, hot, and humid air mass produced by the chance occurrence at the same time of an unusually strong upper-level ridge of high pressure and unusually moist ground conditions.

**Finding:** Long-term processes played no obvious role in the July 1995 heat wave. Given current forecasts skills, there is no reason to believe increased risk of the event could have been anticipated more than a week in advance or can be expected in the future.

**Finding:** The July 1995 heat wave was exacerbated by local effects, including urbanization. This effect was especially notable in Chicago.

## Health Impacts

**Finding:** One of the difficulties with measuring the mortality associated with a heat emergency is the lack of definition for a heat-related death that is both standardized and practical. A standard definition for heat-related death, such as the one used in Chicago, should be developed and adopted for national use by all medical examiners.

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<sup>7</sup> July 1995 Heat Wave Natural Disaster Survey Report, U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Weather Service, Silver Spring, Maryland. December 1995. For copies contact: Customer Service Core (W/OM11), NOAA/National Weather Service, 1325 East-West Highway, Room 14362, Silver Spring, MD, 20910, or on the Internet, go to the NWS Office of Meteorology's Home Page at <http://www.nws.noaa.gov/om/omhome.htm>.

**Finding:** The awareness of heat-related deaths by local medical examiners in Chicago and Milwaukee in 1995 led to the initial recognition in those cities of excess deaths during heat-wave periods.

**Finding:** In Chicago and Milwaukee, the people most affected by the heat were the elderly.

**Recommendation:** Since the elderly in urban areas are in the greatest danger during heat waves, the NWS must proactively focus heat preparedness efforts toward this group.

**Finding:** Heat waves are not clearly recognized as public health emergencies.

**Recommendation:** Emergency response organizations at the Federal, state, and local levels should be encouraged to recognize severe heat waves as potential natural disasters, and areas at risk should be prompted to develop emergency response plans for severe heat waves. These plans should target the groups most often affected by the heat, including elderly persons, particularly those living alone; persons with chronic medical conditions, especially cardiovascular or pulmonary disease; and persons taking psychotropic medications.

**Recommendation:** The analysis of morbidity during the July 1995 heat wave in Chicago and Milwaukee should be investigated by public health officials in order to provide useful public health information about the relationship of morbidity to mortality.

**Finding:** The vulnerability of the elderly in urban core areas was underestimated during the heat wave.

**Recommendation:** Forecasters should target Heat Warnings, Watches, Advisories, and Statements to those groups that are most vulnerable.

## **Provision of NWS Products and Services**

### **■ Chicago, Illinois**

**Finding:** The Extended Forecast Product issued by forecasters at the Chicago NWS Forecast Office communicated the likelihood of high levels of heat and humidity 48 hours prior to the event.

**Finding:** Extended range forecasts of temperatures were generally within 3 to 5 degrees for high temperatures and 5 to 7 degrees for low temperatures.

**Finding:** NWS forecasters at the Chicago Forecast Office communicated a forecast calling for high heat and humidities 36 to 48 hours prior to the event.



**Finding:** Short-range temperature forecasts had state of the art accuracy. High temperature forecasts were accurate to within 3 degrees. Low temperature forecasts were accurate to within 6 degrees. Both were underestimates.

**Finding:** Forecasters used descriptive terminology, such as “muggy” and “humid,” to communicate important weather information.

**Finding:** A Heat Outlook or Heat Watch was not issued as allowed for in WSOM Chapter C-44, Non-Precipitation Weather Hazards.

**Recommendation:** The NWS should ensure that forecasters at all field offices understand the flexibility provided by WSOM Chapter C-44 to issue a variety of critical information products on heat-related issues.

**Finding:** NWS forecasters at the Chicago Forecast Office issued accurate Short Term Forecasts that included temperature, humidity, and heat index levels.

**Finding:** Heat Advisories were issued prior to and during the excessive heat event.

**Finding:** The initial Heat Advisory issued at 3:30 p.m., CDT, July 12, was issued under an incorrect product title (Public Information Statement). A Non-Precipitation Weather Warning should have been issued.

**Finding:** NWS-issued forecast products contained highly detailed and accurate meteorological information, including the heat index, but lacked call to action statements. Heat Advisories were the only products that contained information relating to the potential impact of anticipated weather conditions or call to action information.

**Recommendation:** Forecasters should focus on the health hazards associated with heat in warnings, watches, forecasts, advisories, and statements. All products should include call to action statements.

**Recommendation:** MICs and WCMs at all NWS forecast offices should work with state, city, and local health officials to determine threshold values for dangerous heat index levels tailored to their area.

## Potential For Enhanced Service

Although the excessive heat was well forecast by forecasters at the NWS Forecast Office at Chicago, there are several ways in which service to the public could have been enhanced.

*Enhancement Concept 1: Stress the dangerous nature of excessive heat in*

With forecast or actual temperatures near 100°F, dew points near 80°F, and heat index levels above 110°F, the seriousness of these weather conditions could have been stressed in Warnings, Watches, Advisories, and Statements.

*Enhancement Concept 2: Keep a pulse on the community.*

It was nearly impossible for forecasters to learn of the increasing heat-related deaths until after the peak period of temperature. The earliest indication of a developing crisis was an enormous increase in emergency room admissions. At one point, 18 Chicago-area hospitals were in bypass or unable to admit more people into the emergency room. This occurred relatively early in the event. During times of excessive heat, forecasters should establish contact with public health officials to obtain this information.

*Enhancement Concept 3: Understand local problems of the community.*

Early indications suggest that the elderly in urban areas were vulnerable to the excessive heat. Forecasters should issue targeted products addressed to the most vulnerable.

*Enhancement Concept 4: Develop local studies for the community.*

Once forecasters target specific groups and critical threshold heat values, keep the community informed via frequent statements.

*Enhancement Concept 5: Keep the community well informed.*

Once forecasters target specific groups and critical threshold heat values, keep the community informed via frequent statements.

*Enhancement Concept 6: Work with commercial service providers.*

In some cases, there are thresholds of temperature, humidity, and hence heat index at which heat-related problems increase. Local studies, in cooperation with health officials, could better define these critical values. They will most likely vary from region to region and, perhaps, city to city.

Work with commercial service providers to develop a heat hazards training element for their radio and television customers to improve the on-air delivery of forecast information to the public.

#### ■ Milwaukee, Wisconsin

**Finding:** The Extended Forecast Product issued by forecasters at the Milwaukee NWS Forecast Office clearly communicated the likelihood of unusually high levels of heat 5 days prior to the event.

**Finding:** Extended range forecasts of temperatures were initially 6 to 10 degrees low in the 3- to 5-day range but improved to within 2 degrees in the 1- to 2-day range.

**Finding:** Two Special Weather Statements were issued 40 hours prior to the event and contained call to action information for the elderly and others at risk.

**Finding:** NWS forecasters at the Milwaukee Forecast Office clearly, effectively, and accurately communicated a forecast calling for high heat and humidities 36 to 48 hours prior to the event.

**Finding:** Short-range temperature forecasts were accurate. Initial errors in forecast accuracy improved to within 2 or 3 degrees at least 24 hours prior to the onset of the heat wave.

**Finding:** Forecasters used descriptive terminology, such as “muggy” and “humid,” to communicate important weather information.

**Finding:** A Heat Advisory was issued for 2 consecutive days, providing local officials excellent planning information.

**Finding:** NWS forecasters at the Milwaukee Forecast Office issued accurate Short Term Forecasts that included temperature, humidity, and heat index levels.

**Finding:** Heat Advisories were issued prior to and during the excessive heat event.

**Finding:** Heat index levels were provided in the first period (first 6 hours) of the Zone Forecasts.

**Finding:** NWS-issued forecast products contained highly detailed and accurate meteorological information, including the heat index.

**Finding:** NWS forecasters at the Milwaukee Forecast Office issued frequent Heat Advisories and Special Weather Statements to keep the community well informed.

**Finding:** All warnings, forecasts, advisories, and statements were of high quality and contained accurate forecast details, including heat index levels.

**Recommendation:** MICs and WCMs at all NWS forecast offices should work with state, city, and local health officials to determine threshold values for dangerous heat index levels tailored to their area.

## **Potential For Enhanced Service**

Although forecasters at the NWS Forecast Office at Milwaukee kept the community well informed on the heat wave, there are a few ways in which service could have been enhanced.

*Enhancement Concept 1: Focus on the highest at-risk groups.*

Large urban areas pose unique problems during excessive heat situations. Forecasters are encouraged to provide frequent statements targeted to the groups at higher risk; in this case, the elderly and infirm residing in urban areas.

*Enhancement Concept 2: Keep a pulse on the community.*

It was nearly impossible for forecasters to learn of the increasing heat-related deaths until after the peak period of temperature. The earliest indication of a developing crisis was an enormous increase in emergency room admissions. At one point, several Milwaukee-area hospitals were in bypass or unable to admit more people into the emergency room. This occurred relatively early in the event. During times of excessive heat, forecasters should establish contact with public health officials to obtain this information.

*Enhancement Concept 3: Develop local studies for the community.*

In some cases, there are thresholds of temperature, humidity, and heat index at which heat-related problems are increased. Local studies, in cooperation with health officials, could better define these critical values.

*Enhancement Concept 4: Work with commercial service providers.*

Work with commercial service providers to develop a heat hazards training element for their radio and television customers to improve the on-air delivery of forecast information to the public.

## **Communication, Emergency Preparedness, and Community Response**

**Finding:** Despite timely NWS warnings, forecasts, advisories, statements, and effective media coverage of the event, city officials had neither the experience nor emergency response capabilities to translate the physical characteristics of the heat wave into human impact.

**Recommendation:** NWS offices should work with local officials to develop a public awareness and community response plan for such events, especially among vulnerable or disadvantaged groups.

**Finding:** Media coverage of the July 1995 heat wave in Chicago and Milwaukee was substantial from both meteorological and health angles.

**Finding:** Staff meteorologists at radio and television stations gave the NWS high marks for timely and accurate forecasts and related services during the heat wave.

**Finding:** The Chicago and Milwaukee media have not developed a public response to heat hazards as they have for other severe weather phenomena.

**Recommendation:** The NWS must enhance its public education campaign regarding the use of the heat index and the dangers of heat. The media and the private sector should be enlisted as partners through professional associations, such as the American Meteorological Society and the National Weather Association.

**Finding:** At the time of the July 1995 heat wave, the emergency preparedness program for extreme heat in Chicago was organized and administered from the public health department, which was different from other hazardous weather events.

**Finding:** Officials in Chicago did not realize the difference between NWS weather warnings and private sector warnings.

**Recommendation:** The Chicago NWS Forecast Office should work with Chicago officials to provide user training on NWS watch/warning products.

**Finding:** Chicago and Milwaukee officials and the public did not fully understand the heat index or the extent of the threat from heat waves.

**Recommendation:** The NWS must enhance its community education campaign regarding the use of the heat index and the dangers of heat.

## **Case Studies in Heat Wave Preparedness**

**Recommendation:** NOAA should actively encourage other Federal agencies, such as the Department of Health and Human Services, the Environmental Protection Agency, and the Federal Emergency Management Agency, to join in research on excessive heat, mortality, and morbidity.

**Recommendation:** The NOAA Chief Scientist should convene a workshop comprised of interagency physical scientists, private sector providers, social scientists, and epidemiologists to provide operational research recommendations in light of the scientific advances made over the last decade. The relationship between heat-related mortality and the heat index, as well as other proposed predictors of heat stress, should be simultaneously evaluated to determine which method most accurately predicts the health consequences of a heat wave.

### **■ Philadelphia, Pennsylvania**

**Finding:** Philadelphia's Heat Wave Preparedness Task Force developed an extensive and detailed plan for responding to heat emergencies.

**Finding:** Philadelphia's Heat Response Emergency Plan is activated by Heat Warnings issued by the NWS.

**Finding:** Emergency heat-related activities in Philadelphia are mobilized on the basis of predictions of an alternative model developed by Professor Laurence Kalkstein, Center for Climatic Research, University of Delaware.

**Finding:** It is not clear how much better the Kalkstein model compares with other models in predicting the health effects of a heat wave.

**Recommendation:** The Kalkstein model should be reviewed after its proposed expansion to Chicago, Illinois, and Atlanta, Georgia, in 1996.

**Finding:** NWS forecasters clearly, effectively, aggressively, and accurately communicated a forecast for the Philadelphia area calling for dangerously high heat and humidities 36 to 48 hours prior to the event.

**Finding:** Recognizing the unique situation of an urban center, NWS forecasters issued a Heat Warning for Philadelphia (the highest level possible) for a consecutive 2-day period. This action provided community officials with key planning information.

**Recommendation:** NOAA should quantify the urban heat island effect to incorporate in NWS Heat Warnings, Watches, Advisories, and Statements.

## ■ St. Louis, Missouri

**Finding:** St. Louis' Operation Weather Survival, a loose affiliation of agencies involved in responding to heat emergencies and coordinated by the local chapter of the United Way, developed an extensive and detailed plan for responding to heat emergencies.

**Finding:** The St. Louis Heat Response Plan is activated by Heat Warnings jointly issued by the St. Louis Department of Health and the St. Louis County Health Department, based on readings of a wet bulb globe thermometer not by Heat Warnings issued by the NWS.

**Finding:** NWS forecasters clearly and accurately communicated the likelihood of unusually high levels of heat for St. Louis 5 days prior to the event.

**Finding:** NWS forecasters issued a Heat Advisory for St. Louis for a consecutive 2-day period. This action provided community officials with key planning information.

## Appendix C

# ATTENDEES

## NOAA HEAT WAVE WORKSHOP

September 18-19, 1996  
Silver Spring, MD

Christopher R. Adams  
Office of Meteorology  
National Weather Service, NOAA  
Room 14351  
1325 East-West Highway  
Silver Spring, MD 20910  
adams@cira.colostate.edu

Jean Adams  
Firefighter Health and Safety Specialist  
U.S. Fire Administration, FEMA  
N-315  
16825 S. Seton Avenue  
Emmitsburg, MD 21727

Carl Adrianopoli  
Office of Emergency Preparedness  
U.S. Public Health Service  
17th Floor  
105 W. Adams  
Chicago, IL 60602  
cadriano@phschi.ssw.dhhs.gov

Eugene P. Auciello  
Meteorologist In Charge  
National Weather Service, NOAA  
Albany County Airport  
Albany, NY 12211

Chris Barnes  
Staff Member  
Los Alamos National Laboratory  
MS F645  
Los Alamos, NM 87545

Christopher D. Bayer  
Assistant Director, Center for Medical  
Education Technologies  
Henry M. Jackson Foundation  
1401 Rockville Pike, Suite 600  
Rockville, MD 20852  
bayer@tekamah.com

Alfred M. Beeton  
Chief Scientist  
U.S. Department of Commerce, NOAA  
HCHB Room 5128  
14th & Constitution Avenue, N.W.  
Washington, DC 20230  
abeeton@rdc.noaa.gov

Leo Bosner  
Program Specialist  
Federal Emergency Management Agency  
500 C Street, S.W.  
Washington, DC 20472

Nancy Buechler  
Public Health Educator  
St. Louis Department of Health and  
Hospitals  
634 N. Grand  
St. Louis, MO 63103

Shari Coffin  
Editor  
National Coordinating Council on  
Emergency Management.  
9302 Second Avenue  
Silver Spring, MD 20910  
skayec@aol.com



Robert N. Cooper  
Emergency Management Specialist  
Fairfax County, VA, Emergency Services  
3911 Woodburn Road  
Annandale, VA 22003

H. Denny Donnell, Jr.  
State Epidemiologist  
Missouri Department of Health  
1730 East Elm Street  
Jefferson City, MO 65102-0570  
donned@mail.health.state.mo.us

John Earwood  
Policy Specialist  
PA Department of Aging  
Sixth Floor  
400 Market Street  
Harrisburg, PA 17101  
jearwood@aging.state.pa.us

Allan Eustis  
Office of Industrial Meteorology  
National Weather Service, NOAA  
SSMC2, Room 18102  
1325 East-West Highway  
Silver Spring, MD 20910  
Allan.Eustis@noaa.gov

Michael W. Franjevic  
Warning Coordination Meteorologist  
National Weather Service, NOAA  
PAB 500  
P.O. Box 52025  
Phoenix, AZ 85072-2025  
michael.franjevic@noaa.gov

David Gardiner  
Assistant Administrator  
U.S. Environmental Protection Agency  
Office of Policy, Planning, and Eval.  
Mail Code 7111  
401 M Street, S.W.  
Washington, DC 20460

Jannie Gibson  
Office of Meteorology  
National Weather Service, NOAA  
1325 East-West Highway  
Silver Spring, MD 20910

Tom Glenn  
NHTSA Emergency Preparedness  
Coordinator  
U.S. Department of Transportation  
NAD-40, Room 6130  
400 Seventh Street, S.W.  
Washington, DC 20590

Bob Goree  
Warning Coordination Meteorologist  
National Weather Service, NOAA  
3238 Capitol Circle  
Tallahassee, FL 32310  
goree@noaa.gov

Anne Grambsch  
U.S. Environmental Protection Agency  
401 M Street  
Washington, DC 20460

Ed Gross  
Chief, Industrial Meteorology Staff  
National Weather Service, NOAA  
Room 18462  
1325 East-West Highway  
Silver Spring, MD 20910  
Edward.M.Gross@noaa.gov

Ida Hakkarinen  
NWS Program Specialist/NWS Liaison  
NOAA Program Coordination Office  
HCHB, Room 5811  
14th & Constitution Avenue, N.W.  
Washington, DC 20230  
Ida.Hakkarinen@noaa.gov

Bill Hansbury  
Program Manager, Natural and Technical  
Hazards  
U.S. Department of Veterans Affairs  
Emergency Medical Preparedness  
Medical Center  
Martinsburg, WV 25401

Chet Henricksen, Jr.  
Meteorologist In Charge, Philadelphia  
National Weather Service, NOAA  
732 Woodlane Road  
Mount Holly, NJ 08060  
chet@chesco.com

Brenda Hernandez  
Office of Meteorology  
National Weather Service, NOAA  
Silver Spring, MD 20910

Susan I. Hruska  
Associate Professor of Computer Science  
Florida State University  
Department of Computer Science  
Tallahassee, FL 32306-4019  
hruska@cs.fsu.edu

Samuel H. Jordan  
Director  
D.C. Office of Emergency Preparedness  
Reeves Center, Eighth Floor  
2000 14th Street, N.W.  
Washington, DC 20009

Laurence S. Kalkstein  
Center for Climatic Research  
University of Delaware  
Department of Geography  
206 Pearson Hall  
Lovett and Academy Street  
Newark, DE 19716-2541  
larryk@udel.edu

Richard Koeneman  
Lead Forecaster, Chicago Office  
National Weather Service, NOAA  
333 W. University Drive  
Romeoville, IL 60446  
Richard.Koeneman@noaa.gov

Richard Krajieski  
Church World Service  
114 High  
Mannington, WV 26582  
Ecunet Richard Krajieski

James P. Kramper  
Warning Coordination Meteorologist  
National Weather Service, NOAA  
12 Research Park Drive  
St. Charles, MO 63304-5686  
James.Kramper@noaa.gov

Linda Kremkau  
Office of Meteorology  
National Weather Service, NOAA  
Room 14370  
1325 East-West Highway  
Silver Spring, MD 20910  
Linda.Kremkau@noaa.gov

Theresa Lambert  
Associate Director  
National Association of State Units on Aging  
Suite 725  
1225 I Street, N.W.  
Washington, DC 20005

Jerry Libby  
Planning Supervisor  
Philadelphia Department of Public Health  
Seventh Floor  
1600 Arch Street  
Philadelphia, PA 19103

Robert E. Livezey  
National Centers for Environmental  
Prediction  
National Weather Service, NOAA  
W/NP51  
5200 Auth Road  
Camp Springs, MD 20746-4304

Rocky Lopes  
Manager, Community Disaster Education  
American Red Cross  
Disaster Services Department  
8111 Gatehouse Road  
Falls Church, VA 22042-1203  
lopesr@usa.redcross.org

Kevin McCarthy  
Office of Meteorology  
National Weather Service, NOAA  
1325 East-West Highway  
Silver Spring, MD 20910

Michael A. McGeehin  
National Center for Environmental Health  
U.S. Centers for Disease Control and  
Prevention  
Enviro. Hazards & Health Effects  
Health Studies Branch, F-46  
4770 Buford Highway, N.E.  
Atlanta, GA 30341  
mam7@cehdeh.em.cdc.gov

Barbara McNaught Watson  
Warning Coordination Meteorologist  
National Weather Service, NOAA  
44087 Weather Service Road  
Sterling, VA 20166  
Barbara.McNaught@noaa.gov

Jeff Moran  
Director of Communication  
Philadelphia Department of Health  
1600 Arch Street  
Philadelphia, PA 19102

Othell T. Newbill, III  
Emergency Services Planner  
Maricopa County Department of Emergency  
Services  
2035 N. 52nd Street  
Phoenix, AZ 85008

Donald L. Ocker  
National Weather Service, NOAA  
20 South Vermillion  
Brownsville, TX 78521  
Don Ocker at W-SR-  
BRO@smtpgate.ssmc.noaa.gov

Tom Park  
Emergency Management Specialist  
Federal Emergency Management Agency  
State and Local Preparedness Dir.  
500 C Street, S.W.  
Washington, DC 20472

Gib Parrish  
National Center for Environmental Health  
U.S. Centers for Disease Control and  
Prevention  
4770 Buford Highway  
Atlanta, GA 30341-3724  
rgp1@cehdeh1.em.cdc.gov

Kristina J. Peterson  
Church World Service  
114 High  
Mannington, WV 26582  
Ecunet Kristina Peterson

Roger A. Pielke, Jr.  
National Center for Atmospheric Research  
Environmental and Societal Impacts  
P.O. Box 3000  
Boulder, CO 80307-3000  
rogerp@ucar.edu

Richard Przywarty  
Office of Meteorology  
National Weather Service, NOAA  
1325 East-West Highway  
Silver Spring, MD 20910

Robert G. Quayle  
Chief, Global Climate Lab  
National Climatic Data Center,  
NOAA/NESDIS  
151 Patton Avenue  
Asheville, NC 28801-5001  
rquayle@ncdc.noaa.gov

Barbara J. Robinson  
Information and Assistance Officer  
D.C. Office on Aging  
Suite 950  
441 4th Street, N.W.  
Washington, DC 20001

Lawrence Robinson  
Deputy Health Commissioner  
Philadelphia Department of Health  
Seventh Floor  
1600 Arch Street  
Philadelphia, PA 19103

Barry Rountree  
Graduate Student  
Florida State University  
1327 High Road, #G6  
Tallahassee, FL 32304  
rountree@cs.fsu.edu

Robert J. Rydman  
School of Public Health  
University of Illinois  
Room 227  
2035 West Taylor Street  
Chicago, IL 60612  
rjrydman@uic.edu

Joel D. Scheraga  
Director, Climate and Policy Division  
U.S. Environmental Protection Agency  
Mail Code 2174  
401 M Street, S.W.  
Washington, DC 20460  
scheraga.joel@epamail.epa.gov

Richard W. Schwerdt  
Central Region Headquarters  
National Weather Service, NOAA  
Room 1862  
601 East 12th Street  
Kansas City, MO 64106-2897  
richard.schwerdt@noaa.gov

Bonnie Sharpe  
Office of Meteorology  
National Weather Service, NOAA  
1325 East-West Highway  
Silver Spring, MD 20910

Thomas Sinks  
National Center for Environmental Health  
U.S. Centers for Disease Control and  
Prediction  
F-29  
4770 Buford Highway, N.E.  
Atlanta, GA 30341-3724  
ths2@cdhod1.ed.cdc.gov

John Skoda  
Industrial Meteorology Staff  
National Weather Service, NOAA  
Room 11170  
1325 East-West Highway  
Silver Spring, MD 20910  
John.Skoda@noaa.gov

Anne E. Smith  
Vice President  
Decision Focus, Inc.  
Suite 775  
1150 18th Street, N.W.  
Washington, DC 20036  
dcinet@dfi.com

Fraser Smith  
Decision Focus, Inc.  
Suite 300  
650 Castro Street  
Mountain View, CA 94041  
fraser@dfi.com

Zachary D. Smith  
Public Affairs  
D.C. Office of Emergency Preparedness  
2000 14th Street, N.W.  
Washington, DC 20009  
DCOEP@erols.com

Estella Speaks  
Office of Meteorology  
National Weather Service, NOAA  
1325 East-West Highway  
Silver Spring, MD 20910

Carmen Steigman  
Public Health Laboratory Director  
St. Louis Department of Health and  
Hospitals  
634 N. Grand Boulevard  
St. Louis, MO 63103

James P. Travers  
Washington Forecast Office  
National Weather Service, NOAA  
44087 Weather Service Road  
Sterling, VA 20166-9603

Louis Uccellini  
Director, Office of Meteorology  
National Weather Service, NOAA  
1325 East-West Highway  
Silver Spring, MD 20910

Leon Ware  
Emergency Services Planner  
Maricopa County Department of Emergency  
Services  
2035 N. 52nd Street  
Phoenix, AZ 85008

Joan Weinberg  
Office of Meteorology  
National Weather Service, NOAA  
1325 East-West Highway  
Silver Spring, MD 20910

Don Wernly  
Office of Meteorology  
National Weather Service, NOAA  
1325 East-West Highway  
Silver Spring, MD 20910

Herb White  
Office of Meteorology  
National Weather Service, NOAA  
1325 East-West Highway  
Silver Spring, MD 20910

Tarina A. Whitfield  
Graduate Student, Computer Science  
Florida State University  
Computer Science  
Department 4019  
Tallahassee, FL 32306-4019  
whit@cs.fsu.edu

Gregory C. Wilder  
Senior Aging Services Program Specialist  
U.S. Administration on Aging, DHHS  
Suite 600  
1150 Grand Avenue  
Kansas City, MO 64106

John L. Wilhelm  
Deputy Commissioner  
Chicago Health Department  
DePaul Center, Room 2129  
333 South State Street  
Chicago, IL 60611  
Pyunic@aol.com

Courtney Williams  
Community Planner  
D.C. Office on Aging  
Suite 950  
441 4th Street, N.W.  
Washington, DC 20001

Tom Wilson  
Electric Power Research Institute  
3412 Hillview Avenue  
Palo Alto, CA 94304-1395  
twilson@eprinet.epri.com

Alexander Winslow  
Communications Officer  
U.S. Environmental Protection Agency  
Office of Economy and Environment  
Mail Code 2122  
401 M Street  
Washington, DC 20460  
winslow.alexander@epamail.epa.gov

Derek Winstanley  
Deputy Chief Scientist  
NOAA Office of the Chief Scientist  
HCHB, Room 5224  
14th & Constitution Avenue, N.W.  
Washington, DC 20230  
dwinstanley@rdc.noaa.gov

Susan F. Zevin  
Deputy Assistant Administrator for  
Operations  
National Weather Service, NOAA  
Wx1, Room 18164  
1325 East-West Highway  
Silver Spring, MD 20910-3283

## **Appendix D**

### **Follow-up Activities to the NOAA Heat Wave Workshop**

#### **Current NWS Heat Wave Forecast and Warning Practices Working Group**

In support of the recommendation for better awareness of the heat wave problem by local agencies and the media, a new NOAA/NWS Heat Wave brochure has been drafted. Kevin McCarthy is coordinating the work of Jim Allsopp, Warning Coordination Meteorologist, NWSFO Chicago, Illinois, to complete this brochure.

Current NWS operational guidance is being reviewed and revised in light of the recommendations from the Heat Wave Workshop. Ideas from the Workshop are being written into new procedures for NWS field operations starting the summer of 1997. This will either take the form of an OML or a complete rewrite of the WSOM chapter covering heat waves.

#### **Research Requirements to Better Forecast and Mitigate the Effects of Heat Waves Working Group**

##### **A PROCEDURE TO EVALUATE THE EFFECTIVENESS OF TWO WATCH/WARNING SYSTEMS**

by

The Subcommittee for the Comparative Evaluation of Existing  
Heat-Related Watch/Warning Systems and Predictive Models

NOAA Heat Wave Workshop Working Group on Research Requirements to  
Better Forecast and Mitigate the Effects of Heat Waves

Robert Livezey  
NOAA/Climate Prediction Center  
Laurence Kalkstein  
University of Delaware/Center for Climatic Research  
Chris Barnes  
Los Alamos National Laboratory  
Gib Parrish  
U.S. Centers for Disease Control and Prevention

A meeting of the Subcommittee was held on November 6, 1996, at the University of Delaware to develop statistical procedures which would evaluate the effectiveness of at least two heat/health watch-warning system approaches. This would be accomplished through a

comparative evaluation of heat-related mortality prediction. Participants at the meeting, other than the Subcommittee members listed above, were: Emilio Esteban, CDC; Jerry Libby, Philadelphia Department of Public Health; and Steven Yoon, CDC. An agreed upon plan of action was developed and is reported below.

An objective evaluation is to be performed on two specific procedures which have potential use in heat/health watch-warning systems. The first is an apparent temperature-based system which has its roots in NOAA procedures for heat warnings. The second is an air mass-based classification developed at the University of Delaware which is presently in use by the Philadelphia Department of Public Health and will be used by the DC Office of Emergency Preparedness beginning summer 1997.

For this objective evaluation, a mandatory requirement is a "level playing field" for both procedures. This includes three key components. First, the identical data sets will be used to evaluate both procedures. Second, minimum values for apparent temperatures that must be exceeded for mortality to be impacted will be established (such "thresholds" are already internally determined in the air mass-based procedure). This optimizes the possibility of determining significant linear relationships in the next step. Third, regression equations with appropriate independent variable which evaluate mortality variability will be constructed for both procedures for cases in which thresholds are exceeded. The selection of the independent variables will be done parsimoniously with a pool of no greater than 6 and with the expectation that final regression equations will have approximately 3 terms.

We propose that a sufficient number of cities be evaluated so that all of the climate regions of the country are represented. No less than 20 cities will be examined, all with large populations to decrease the amount of noise in mortality variation. Data will be standardized using procedures recommended by the CDC. Besides an evaluation of total deaths, several mortality subsets will be developed to exclude those causes which are clearly not related to heat. CDC will assist in the selection procedure of mortality causes. Finally, we will avoid use of data during post-mitigation periods where rigorous attempts have been made to decrease heat-related mortality.

To estimate skill levels that will be realizable in practice, the two mortality prediction schemes will be tested on independent data through the use of a full cross validation. This is a technique whereby data for individual summers are sequentially withheld from the analytical procedures, and the resulting test models are then evaluated on the withheld data. For example, assuming a 20-year data set, relationships will be developed on 19 years and the 20th year will be withheld for evaluation. This will be repeated 20 times, reserving a different test year each time. Every step in the modeling procedure is redone in this cross validation, each time excluding the evaluated year. Thus, no step in the procedure (threshold determination, regression fitting, etc.) will have knowledge of what occurs within the evaluated year. Forecasts will be made in both categorical and continuous quantitative forms and will be thoroughly evaluated with modern verification techniques.

It is the Subcommittee's hope that the results of this test will be used to alter present procedures to evaluate heat/health problems. Further, we believe that this evaluation will



provide a demonstration of the necessity for regionally varying criteria for heat-related health alters. The Working Group on Current NWS Heat Wave Forecasts and Warning Practices at the NOAA Heat Wave Workshop recommended that local National Weather Service offices have the flexibility to apply these regionally-varying criteria, which few currently do. Another demonstration of the evaluation will be the power of regression techniques (or other empirical models) to quantify the level of danger. Finally, this study should provide guidance on which weather-related factors to focus.

A research proposal has been submitted for funding to conduct the first stage of this research. The final decision by the funding agency is pending.

## **Identifying and Transferring Successful Community Intervention Strategies Working Group**

A subset of this group, lead by Mike Franjevic, has continued work on developing the heat wave preparedness community planning tool. The initial ideas from the Workshop have been refined by representatives from FEMA, the NWS, CDC, and Church World Services. This small group has proposed creating a task team of people representing local and state emergency management and public health agencies, disaster volunteer agencies, CDC, AoA, EPA, FEMA, and NWS. It is proposed that the task team come together at a site like FEMA's National Emergency Training Center to develop a heat wave planning tool, or job aid, that could be used to train state and local officials. The final document would be used by states and communities to help guide the heat wave response planning process. It would be completed and distributed by summer 1997.

Several people from NWS and FEMA are developing the task team and basic planning tool development agenda and outlining the goals, tasks, and objectives for the development meeting. They are working to identify a variety of funding sources to cover costs to conduct this meeting.